Published in final edited form as:

J Dev Behav Pediatr. 2012 July ; 33(6): 486–494. doi:10.1097/DBP.0b013e31825b849e.

Adiposity and Physical Activity Are Not Related to Academic Achievement in School-Aged Children

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Abstract

Objective—To investigate the hypotheses that in elementary school students: 1) adiposity and academic achievement are negatively correlated and 2) physical activity and academic achievement are positively correlated.

Method—Participants were 1963 children in fourth through sixth grades. Adiposity was assessed by calculating body mass index (BMI) percentile and percent body fat and academic achievement with statewide standardized tests in four content areas. Socioeconomic status and age were control variables. A subset of participants ($n = 261$) wore an accelerometer for three days to provide objective measurement of physical activity. Additionally, the association between weight status and academic achievement was examined by comparing children who could be classified as “extremely obese” and the rest of the sample, as well as comparing children who could be classified as normal weight, overweight, or obese. Extreme obesity was defined as ≥ 1.2 times the 95th percentile.

Results—Results indicated that there were no significant associations between adiposity or physical activity and achievement in students. No academic achievement differences were found between children with BMI percentiles within the extreme obesity range and those who did not fall within the extreme obesity classification. Additionally, no academic achievement differences were found for children with BMI percentiles within the normal weight, overweight, or obese ranges.

Conclusion—These results do not support the hypotheses that increased adiposity is associated with decreased academic achievement or that greater physical activity is related to improved achievement. However, these results are limited by methodological weaknesses, especially the use of cross-sectional data.

Key terms

childhood; academic achievement; adiposity; physical activity

Childhood overweight and obesity have increased over the past decades¹ with children residing in rural areas and those of ethnic minority status being disproportionately impacted.² Childhood overweight and obesity have been associated with negative physical health outcomes, decreased quality of life, and psychological distress.^{3,4} In response, childhood overweight and obesity have been identified as a pressing public health problem, leading to calls for increased efforts to treat and prevent childhood obesity.^{3,5} School-based settings may be an effective location to conduct prevention and intervention activities. However, many schools, under pressure to increase academic achievement, have decreased or eliminated recess and physical education⁶ and may hesitate to spend instructional time on nutrition education or interventions. Research is warranted to investigate potential associations among childhood overweight and obesity, physical activity, and academic achievement to address constraints in schools.

Adiposity and Academic Achievement

Different methods have been used to assess adiposity, including self-reported or directly-measured height and weight, used to calculate body mass index (BMI), or percentage body fat, and academic achievement, including self-reported grade point average (GPA), teacher-assigned GPA, or standardized test scores. Research findings have been equivocal concerning the association between adiposity and academic achievement and these differing methodologies may account for the divergent findings. An inverse association has been found in studies utilizing BMI calculated with self-reported data and academic achievement; however, this association has been weak or inconsistent across demographic groups. For example, Sabia⁷ found a negative body weight-achievement relation for white girls, but not for nonwhite girls or boys of any ethnic group. Results were statistically significant, but a 50–60 pound (22.7 to 27.3 kg) weight increase was associated with only a 0.2 GPA reduction. Reliance on self-reported data for BMI and academic achievement is a limitation. Children and adolescents can be inaccurate reporters of BMI⁸ and academic performance⁹ and method bias also may limit self-report. In support, Huang et al. found different results in the same sample, depending on measurement of achievement. Overweight status was inversely related to achievement in middle school children, but only for self-reported grades. There was no BMI-achievement relation for teacher-reported grades.¹⁰

Recognizing these limitations, researchers have used standardized measurements of weight and achievement and found negative and significant, yet weak, correlations. Obese status was related to lower test scores in kindergarten in a national sample, but the correlation weakened or disappeared when SES and other variables were controlled.¹¹ Datar and Sturm¹² examined change in weight from kindergarten to third grade with three groups:

never overweight, became overweight, and always overweight. Girls who became overweight had significantly lower test scores than girls who had never been overweight, although parental income and education were more strongly related to achievement than weight status change. There were no differences between girls who had always been overweight and those who had never been overweight, or any significant results for boys.¹² These results did not support a strong inverse association between weight and academic achievement.

Any correlation between adiposity and academic achievement may be attributed to mediator variables, such as weight bias or teasing. One study examined weight and academic achievement in a middle school sample using teacher-assigned GPA and a standardized reading assessment. Lower achievement was found for teacher-assigned grades, but not for the reading test.¹³ Overweight students may have been assigned lower grades by teachers due to weight bias; in support of this possibility, researchers have documented weight bias in educators, e.g., negative beliefs about obese children.³ Concerning negative peer interactions, Krukowski et al. found a weak, yet significant relationship between BMI and parent-reported grades in girls, but not boys. When weight-based teasing was added to the model, the BMI-grade association disappeared, indicating that weight-bias teasing functioned as a mediator variable.¹⁴

Physical Activity

Research on the relation between physical activity and academic achievement has also yielded inconsistent findings across studies. Also, similar to the adiposity-achievement research, studies on the relationship between physical activity and academic achievement have used different methods to assess both variables. Some studies with self-reported physical activity have reported a positive association. For instance, Stevens et al.¹⁵ investigated parent- and school-reported physical activity and test scores in a national sample and found a small, yet significant correlations ($r = 0.11$ to 0.16) between parent-reported physical activity and test performance, but not school-based physical education ($r = 0.01$ to 0.04). Conversely, other studies found weak negative associations ($r = -0.03$ to -0.07) between physical activity and achievement.^{16,17} These equivocal findings may be related to the questionable reliability and validity of self- and parent-report for children. Developmental differences between adults and children, including children's different concepts of time; sensitivity to socially desirable responding; and difficulty separating behavioral intentions and actual behavior, may decrease the psychometric properties of self-report.¹⁸ In support, a review of assessment methods revealed that self- and parent-reports overestimated physical activity compared to accelerometry and heart rate monitoring.¹⁸

Randomized controlled trials (RCT) designed to increase physical activity during school have examined changes in academic achievement. Some studies have found that physical activity interventions in schools do not lead to improved academic achievement.^{19–21} Conversely, one RCT found greater achievement gains for intervention schools than control schools across three years.²² Overall, evidence suggests that time spent in physical activity does not result in academic decline and may be associated with gains.

Several mechanisms for the physical activity-achievement link have been proposed. For example, the executive functioning hypothesis posits that physical activity improves executive functioning, as well as other neuropsychological processes, such as processing speed and visual-spatial processing. These improved functions enable children to develop behaviors necessary for academic achievement, such as planning, metacognition, attention, and behavioral self-control.²³ Other psychological constructs, such as depression and self-esteem, may also serve as mediators of the physical activity-achievement association.

However, Tomporowski et al. recently noted that there is no strong theory underlying any association between exercise and cognition.²³

Current Study

Recent studies have reported that the connection between childhood overweight and obesity and reduced achievement has been unequivocally supported in the literature (e.g., Cho et al.²⁴). However, the evidence for this association is mixed and leans towards no meaningful association between adiposity and academic achievement. Studies that found a stronger inverse relation generally relied on self-report. Those with objective assessment have found either weak correlations or that significant correlations are diminished when other variables, such as SES, are statistically controlled. Nonetheless, the hypothesis that being overweight or obese is associated strongly with diminished academic achievement persists. Similarly, studies of physical activity and academic achievement are limited by methodological weaknesses, such as reliance on self-report and different operational definitions of physical activity, and results are mixed. A recent review of the literature concluded that research using accelerometry to measure physical activity is needed to test the hypothesis that higher levels of physical activity are associated with higher academic achievement.²⁵ In conclusion, the associations among adiposity, physical activity and academic achievement in children are unclear due to conflicting findings and differences in methodological rigor. The primary aims of this cross-sectional study were to test the following two hypotheses in a relatively large sample of elementary school students using objective measurement of body weight, academic achievement, and physical activity: 1) there is a negative correlation between adiposity (defined by body mass index percentile and percent body fat) and academic achievement and 2) physical activity is positively correlated with academic achievement.

METHOD

Participants

Participants were 1963 students (mean age = 10.5, $SD = 1.2$) in fourth through sixth grades from the Louisiana (LA) Health project. LA Health was designed to prevent inappropriate weight gain in rural schools (See Williamson et al.²⁶ for details). This sample included all participants for which academic achievement data were available. The sample was 59.7% female ($n = 1172$) and 40.3% male ($n = 791$). The average BMI percentile was 69.6 ($SD = 29.4$) and the average estimated percent body fat was 25.3% ($SD = 11.5$). See Table 1 for details concerning the demographic, academic, and body weight characteristics of the study sample.

The LA Health study also included a sub-study of physical activity using accelerometry as an objective method of measuring physical activity. This sub-study included 261 students (mean age = 10.36, $SD = 1.09$). Originally, 564 children were randomly selected to participate and 310 children signed consent. Students who were absent during measurement, dropped out of the study, or had accelerometers that malfunctioned or had missing data were excluded ($n = 48$), resulting in a sub-study sample size of 261 students. The sub-sample was similar to the entire sample in terms of gender, BMI percentile, percent body fat, self-reported physical activity, and academic achievement (See Table 1). There were slightly more African-American students in sub-sample compared to the entire sample ($\chi^2 = 9.39$, $p < .01$).

Measures

Academic Achievement—Academic achievement data were obtained from the Louisiana Department of Education. All public school students complete criterion-referenced tests annually in English/language arts (ELA), mathematics, science and social studies. Psychometric data support the reliability and validity of the tests.²⁷

Body Mass Index Percentile (BMI %tile)—Height was measured with a portable stadiometer and weight with a Tanita model scale. Children were wearing standard school uniforms without socks and shoes. BMI was calculated from height and weight (kg/m^2). Since BMI increases with age, the BMI of each participant was converted to a BMI %tile based on gender and age norms from the Centers for Disease Control.²⁸

Estimated Percent Body Fat—Estimated percent body fat was analyzed using the Tanita Body Composition Analyzer (TBF-310), which measures body weight and impedance concurrently and automatically records body fat and lean body mass to a laptop computer.

Accelerometry—The children in the sub-study wore an ActiGraph GT1M accelerometer for three consecutive weekdays. The 30-second epoch was utilized. A complete day was considered at least 10 hours of wear time and data were included if at least two complete days of data were available. Exclusionary criteria included periods of at least 5 minutes of the exact same count (this represented device malfunction) and any periods of 60 consecutive minutes or greater of zero counts. Children were asked at the end of the assessment to self-report time spent sleeping, which was estimated to the nearest five minutes. The 10 hour requirement was met after ignoring consecutive zeros, erroneous data, and sleep time.

Counts per minute were calculated by dividing total counts by the total number of minutes the device was worn. Equations were used to calculate levels of activity based on counts. The Trost equation divides physical activity into three levels: light, moderate, and vigorous.²⁹ Vigorous activity accounted for less than five minutes per day, so moderate and vigorous activities were combined (MVPA). Sedentary behavior (SED) was calculated as counts less than 100 in accordance with NHANES 2003–2004 analysis.^{30,31}

Socioeconomic Status—SES was defined using data from the National School Lunch Program provided by the state. Children from families with incomes at or below 130% of the poverty level are eligible for free school meals; those between 130% and 185% of the poverty level are eligible for reduced-price meals; and those above 185% of the poverty level pay full price for meals. A three level variable derived from students' lunch code (1 = low SES, 2 = low to moderate SES, 3 = moderate to high SES) served as a proxy variable for SES.

Demographic Data—Birthdates were reported by parents and confirmed by school records. Gender and ethnic status were obtained from school records.

Procedure

Data were collected in a secure environment at the schools as a part of baseline measurement for LA Health. Testing data was provided by the state Department of Education.

Data Analytic Plan

The hypotheses were tested using three statistical methodologies. First, the association between academic achievement, measured by standardized test scores, and adiposity, measured by percent body fat and BMI percentile or BMI z-scores, was examined in a large sample of students. The contribution of SES, gender, and age were included in these analyses. Ethnicity could not be included as it was significantly associated with SES ($\chi^2 = 29$, $p < 0.01$, Contingency Coefficient = 0.35). Test scores were standardized to account for slight differences across grade-levels. The correlations between the achievement content tests (ELA, mathematics, science, and social studies) were high, ranging from .62 to .74. Due to these correlations and to reduce the total number of analyses, canonical correlation analysis was selected as the most appropriate statistical procedure to test the hypotheses. Canonical correlation is a multivariate statistical procedure to determine the correlation between two sets of variables, allowing for the examination of interrelations about sets of variables.³² Second, the associations between adiposity, physical activity and achievement were examined in a sub-study of students who wore accelerometers. As mentioned previously, self-reported physical activity introduces considerable methodological weaknesses and the accelerometer sub-study addressed those concerns and extended the physical activity-academic achievement literature. Third, the association between adiposity and academic achievement was investigated through the examination of group differences. Children were classified using the three groups traditionally found in this literature: normal weight (BMI percentile <85), overweight (BMI percentile ≥ 85 and < 95, and obese (BMI ≥ 95). Additionally, children who could be classified as “extremely obese,” according to recent recommendations from the Centers for Disease Control,³³ were compared to the other children in the sample. Extreme obesity was defined as ≥ 1.2 times the 95th percentile.³³ This “extreme group” methodology was selected as youth classified extremely obese have demonstrated higher rates of physical and psychosocial difficulties than others. The “extreme group” methodology may increase the likelihood of detecting differences that may not appear when all levels of a variable are included.³⁴ The significance level was .01 to control for alpha inflation.

RESULTS

Description of the study sample

Descriptive statistics for demographic characteristics, body weight/fat, and academic achievement for the entire sample and the accelerometry sub-study are presented in Table 1. Pearson product-moment correlation coefficients for the entire sample are presented in Table 2 and for the sub-study in Table 3. These correlations revealed that the academic achievement content areas were positively correlated in both samples, with correlations ≥ 0.60 . BMI percentile, BMI z-score, and percent body fat were not correlated with achievement. SES was positively correlated with all achievement scores, but the correlations were weak (r , 0.19 to 0.28). Neither measured moderate to vigorous physical activity nor sedentary behavior was associated with the academic achievement content areas. Spearman’s rho correlation coefficients indicated that gender was correlated with percent body fat, such that being a girl was associated with higher percent body fat. All data were evaluated for skewness and kurtosis and the results indicated distributions that were appropriate for the subsequent analyses.

Power Analyses

Results of power analyses indicated that there was adequate power to detect correlations of 0.10 for analyses involving the entire sample and correlations of 0.20 for those involving the accelerometry sub-study.

Canonical Correlation Analyses

Table 4 summarizes the canonical correlation analyses results for the entire sample ($n = 1963$). The achievement scores (mathematics, science, social studies, and ELA) were entered, as were age, SES, gender, BMI %tile, and percent body fat. The first correlation was significant ($R = .32$). Canonical loadings of $> .60$ were interpreted, reflecting “very good” loadings;³² therefore, this correlation was between the achievement scores, age, and SES. Being older and of lower SES was associated with decreased achievement. The second correlation also was significant ($R = .12$), but no variables had strong loadings, except SES. The analyses were conducted using BMI z-scores, instead of BMI percentile, and results were identical.

For the accelerometry sub-study, one canonical correlation analysis was conducted ($n = 261$; Table 5). The achievement scores (mathematics, science, social studies, and ELA) were entered, as were age, SES, gender, BMI %tile, percent body fat, time spent in sedentary behavior (SED) and moderate to vigorous physical activity (MVPA). The first correlation was significant ($R = .36$). The correlation was between the achievement scores (mathematics, science, and social studies) and SES, such that higher SES was associated with increased achievement. The second correlation approached significance ($R = .33$, $p = .016$) and was between ELA and gender, such that being a girl was associated with increased ELA achievement. Again, the analyses were conducted using BMI z-scores and results were identical.

Analysis of Covariance

Children were divided into two groups to examine any relationship between extreme obesity and academic achievement. Extreme obesity was defined as ≥ 1.2 times the 95th percentile³³ and 12.2% ($n = 240$) of the participants were in this group. A series of $2 \times 2 \times 4$ analyses of covariance (ANCOVAs) were performed for each achievement test. In the first set, independent variables included weight status (BMI percentile > 1.2 times the 95th percentile and BMI percentile ≤ 1.2 times the 95th percentile), gender (male and female), and age group (aged 9 years and under, 10 years, 11 years, and 12 years and older). Individual student SES and mean school SES were covariates. Random effects of school were controlled. There were no main effects for BMI percentile (F , .02 to .24, p , .63 to .89) or interactions (F , .00 to 1.58, p , .19 to .95) in any analysis.

Also, children were divided into three groups (normal weight, overweight, and obese) to examine any relationship between weight status and academic achievement. A series of $3 \times 2 \times 4$ ANCOVAs were conducted and, again, there were no main effects for BMI percentile (F , .10 to 2.65, p , .07 to .91) or interactions (F , .08 to 2.22, p , .03 to .95) in any analysis.

DISCUSSION

The purpose of this study was to examine the relations among adiposity, physical activity, and academic achievement in elementary school students. To address limitations of previous research, this study utilized objective measurement of adiposity (i.e., BMI percentile and percent body fat) and academic achievement (i.e., statewide standardized test scores). Additionally, this study was the first in this area to utilize objective measurement of physical activity (i.e., accelerometry).

Adiposity

Adiposity, measured with BMI percentile and percent body fat, was not uniquely correlated with academic achievement and there were no group differences found for children classified as normal weight, overweight, or obese. Moreover, results comparing children

classified as extremely obese (BMI percentile > 1.2 times the 95th percentile) and those who were not found no differences for any academic achievement content area. These results are not consistent with previous findings of an inverse relation between BMI status and academic achievement, measured by self-reported weight and height (e.g., Sabia⁷) or measured BMI status (e.g., Roberts et al.³⁵), but are consistent with others (e.g., Xie³⁶). Additionally, no significant results were found when adiposity was measured with percent body fat. The current study is unique in that most previous research has used BMI percentile to quantify adiposity, with the exception of Huang et al.,¹⁰ who also did not report an association between percent body fat and achievement. Confidence in these results can be buttressed by the statistical power of this study.

Academic achievement was uniquely correlated with SES, measured by the proxy measure of free/reduced lunch status. This finding is consistent with previous research reporting that the weight-achievement correlation is greatly reduced, and often disappears, when socioeconomic variables are introduced into statistical models. For instance, Datar et al.¹¹ found that the association between BMI and test scores disappeared for girls and held only for boys in mathematics when variables such as SES were added to the analyses. Moreover, both adiposity and achievement are correlated with SES.³⁷ This study supported the null hypothesis that adiposity was not significantly correlated with academic achievement. Shared variance between SES and adiposity may better account for the positive findings reported in previous studies.

The theoretical basis for the hypothesis that adiposity would be inversely related to academic achievement is weak. Some studies found a link between adiposity and cognitive functioning deficits, particularly on tests of executive functioning, but this literature also is inconsistent.³⁸ It has been posited that this association may be observed only at a certain threshold, such as within obese populations,³⁸ but the results of our analyses utilizing the extreme obesity group differences did not support any association between obesity and academic achievement. Further research utilizing a longitudinal design and controlling for a variety of potentially confounding variables is necessary to increase confidence in the lack of an association between adiposity and academic achievement.

Physical Activity

The second hypothesis was that physical activity would be positively correlated with academic achievement. With physical activity measured with accelerometers, physical activity did not emerge as a correlate with test scores, indicating a lack of support for the second hypothesis. This study extends the literature as this is the first to utilize direct assessment of physical activity in the examination of the physical activity-achievement association. These results were inconsistent with previous studies that found a significant and positive association between physical activity and achievement in elementary school students (e.g. Stevens et al.¹⁵), but consistent with research that did not find significant correlations in Chinese¹⁷ or Australian³⁹ youth. Recent research has indicated that direct measures, such as accelerometers, yield superior results than self-report measures of physical activity.¹⁸ These results also are partially consistent with a recent RCT concerning an aerobic exercise intervention for previously sedentary, overweight children. Davis and colleagues did not find significant differences between the control and exercise groups for reading or mathematics achievement, although they found a dose-response for the shorter and longer exercise duration groups.⁴⁰ They posit that physical activity may be associated with improved cognitive functioning via movement-induced neural stimulation,⁴⁰ but these results do not support that physical activity is associated with increased performance on standardized test of achievement. It should be noted the accelerometry sub-study had lower power than the entire sample, but it did have sufficient power to detect small correlations of

0.20. Nonetheless, the cross-sectional nature of these results limits the confidence in these results.

Strengths and Limitations

This study had a relatively large sample size for examining the first hypothesis, used two objective measures of adiposity, and used an objective measure, i.e. accelerometers, to measure physical activity. A key strength is the use of an objective measure of physical activity. A recent review of the literature concerning the physical activity-achievement relation found a dearth of research using strong methodology and called for research using accelerometry.²⁵ This study also had several limitations. Importantly, these data are cross-sectional, limiting the conclusions that can be drawn. Potential confounding variables, such as pubertal status or time spent engaged in sedentary and academic pursuits (e.g., homework) or nonacademic (e.g., video games), were not addressed. Additionally, canonical correlation analyses did not control for differences between schools and, resultantly, interclass correlations were high. Due to the very high correlations among the achievement content areas, canonical correlation was selected as the optimal statistical method, but school-level differences could not be controlled. To address this concern, school differences were controlled in the group analyses and results of group analyses were consistent with those of the canonical correlation. Another limitation involves generalizability of the findings. Participants attended rural schools and these results may not be applicable to urban children. Concerning the accelerometer sub-study, participants appeared to spend less time engaged in moderate to vigorous physical activity and more time in sedentary activity than children from a national sample.⁴¹ Moreover, about half of the children randomly selected for participation in the accelerometer sub-study agreed to participate; therefore, volunteers may be different from the rest of the sample. The accelerometry data also have limitations. Activity was not measured on the weekends and the accelerometer did not capture activity for every minute or time spent bicycling and swimming.

Directions for Future Research

The results of this study did not support the hypotheses that adiposity is related to lower academic achievement, that overweight and obese children evidence lower academic achievement than normal weight children, or that higher levels of physical activity are associated with better academic achievement. Concerning adiposity and achievement, there is no clear mechanism by which adiposity, itself, should be related to poorer performance on standardized tests. Stigma associated with obese status may account for any weaker academic performance, in that teacher may assign lower grades to or weight-based teasing may decrease school engagement in obese students. The design of this study did not allow for a test of these mediators. Nevertheless, these analyses failed to find an association between adiposity and academic achievement test scores; therefore there was no need to test for mediation. This study and others of similar methodological strength indicate that the adiposity-academic achievement association is not a valuable line of research. Future research should shift the focus from adiposity and consider mediators of the SES-lower achievement link or the impact of weight-based bias, bullying, and teasing on children's academic performance.

Regarding physical activity and achievement, one study reported a strong association⁴² and another found a dose-response of aerobic exercise on math only,⁴⁰ but the study reported here and others¹⁷ do not support that hypothesized relationship. Research has suggested that school-based physical activity programs are not associated with decreased achievement. Future research should examine whether increased time spent in physical activity during the school day actually displaces time spent in academic tasks and, if so, the effects of this displacement on academic achievement. Moreover, preliminary evidence indicated that

aerobic exercise may be associated with improved executive functioning in overweight children who were previously sedentary.⁴⁰ Future research should consider the association between physical activity and other school-related outcomes, such as behavioral self-control and sustained attention to instruction.

Acknowledgments

We would like to express our appreciation to the Louisiana Department of Education for assistance with data. The authors also appreciate the support of the LA GEAR UP program and the LA Board of Regents.

This project was supported by the National Institute for Child Health and Human Development of the National Institutes of Health (R01 HD048483) and the U.S. Department of Agriculture (58-6435-4-90). The clinical trial number for this project is: NCT00289315. In addition, this work was partially supported by the NORC Center Grant #1P30 DK072476 entitled "Nutritional Programming: Environmental and Molecular Interactions" sponsored by NIDDK.

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Table 1

Sample Characteristics

Variable	Entire Sample		Accelerometry Subsample	
	n	% or Mean (SD)	n	% or Mean (SD)
Age	1963	10.5 (1.2)	261	10.4 (1.1)
Females	1172	59.7%	173	66.3%
Free school lunch	1566	79.8%	204	78.2%
Reduced school lunch	123	6.3%	17	6.5%
Paid school lunch	274	14.4%	40	15.3%
African-American	1338	68.0%	199	76.3%
Caucasian	592	30.2%	62	23.8%
“Other” ethnicity	36	1.8%	0	0
BMI %tile	1963	69.6 (29.4)	261	70.0 (28.2)
Percent body fat	1963	25.3 (11.5)	261	26.2 (11.4)
English/language arts	1963	296.6 (53.6)	261	300.3 (50.4)
Mathematics	1963	296.2 (60.4)	261	298.9 (58.7)
Science	1963	290.0 (50.7)	261	291.8 (47.5)
Social studies	1963	293.5 (47.5)	261	295.2 (42.4)
Percent SED			261	58.9 (7.8)
Percent MVPA			261	5.2 (2.6)

BMI %tile, body mass index percentile; SED, sedentary behavior; MVPA, moderate to vigorous physical activity

Table 2

Bivariate Correlations: Total Sample

	1. ELA	2. Math	3. Sc	4. SS	5. BMI %tile	6. BMI z score	7. % BF	8. SES	9. Gender
1. ELA	—								
2. Math	.72*	—							
3. Sc	.66*	.67*	—						
4. SS	.63*	.60*	.67*	—					
5. BMI %tile	-.01	-.02	.01	.03	—				
6. BMI z score	-.01	-.02	.01	.02	.97*	—			
7. % BF	.02	-.03	-.01	.01	.78*	.86*	—		
8. SES	.20*	.23*	.22*	.21*	-.01	.01	-.02	—	
9. Gender	-.17*	.02	-.02	-.01	.01	.01	.25*	.02	—

n = 1963; ELA, English/language arts; Math, mathematics; Sc, science; SS, social studies; BMI %tile, body mass index percentile; % BF, percent body fat; SES, socioeconomic status.

* $p < .01$.

Table 3

Bivariate Correlations: Accelerometry Substudy

	1. ELA	2. Math	3. Sc	4. SS	5. BMI %tile	6. BMI z score	7. % BF	8. SES	9. Gen	10. SED	11. MVPA
1. ELA	—										
2. Math	.68*	—									
3. Sc	.60*	.67*	—								
4. SS	.66*	.63*	.64*	—							
5. BMI %tile	-.03	-.002	.06	.07	—						
6. BMI z score	-.04	.01	.05	.06	.96*	—					
7. % BF	-.001	-.04	.005	.02	.79*	.88*	—				
8. SES	.19*	.28*	.24*	.23	-.04	-.03	-.06	—			
9. Gen	.14	-.005	-.02	-.05	.01	.01	.22*	.18*	.02	—	
10. SED	.11	.05	.06	.07	.10	.10	.18*	.10	.02	—	
11. MVPA	-.15	-.09	-.11	-.08	-.14	-.14	-.19*	-.11	-.14	-.49*	—

n = 261; ELA, English/language arts; Math, mathematics; Sc, science; SS, social studies; BMI %tile, body mass index percentile; % BF, percent body fat; SES, socioeconomic status; Gen, gender; SED, sedentary behavior; MVPA, moderate to vigorous physical activity.

* $p < .01$.

Table 4

Canonical Correlation Analysis: Total Sample

	Canonical Correlation 1	Canonical Correlation 2	Canonical Correlation 3	Canonical Correlation 4
Canonical correlation	.33*	.26*	.05	.04
Academic achievement				
ELA	.97	-.15	.04	.16
Mathematics	.83	.39	-.39	-.08
Science	.66	.51	.09	.55
Social studies	.73	.45	.49	-.15
Psychosocial, adiposity, and physical activity				
Age	-.74	-.08	-.14	.63
BMI %tile	-.02	.09	.93	.16
% Body fat	-.03	-.15	.89	.32
SES	.66	.86	-.15	.57
Gender	.44	.46	.04	.22

ELA, English/language arts; SES, socioeconomic status; BMI %tile, body mass index percentile. n = 1963; Correlations of variables with canonical functions >.60 are shown in bold.

*
p < .01.

Table 5

Canonical Correlation Analysis: Accelerometry Substudy

	Canonical Correlation 1	Canonical Correlation 2	Canonical Correlation 3	Canonical Correlation 4
Canonical correlation	.36*	.33	.11	.08
Academic achievement				
ELA	.46	.86	.19	.13
Mathematics	.83	.44	-.30	-.13
Science	.77	.21	-.04	.60
Social studies	.82	.22	.53	-.02
Psychosocial, adiposity, and physical activity				
Age	-.49	-.14	-.41	.68
BMI %tile	.20	-.29	.55	.46
% Body fat	-.03	-.05	.62	.37
Total physical activity	-.15	-.43	-.18	-.76
Total sedentary activity	.09	.28	.49	.41
SES	.78	.25	-.37	.08
Gender	-.25	.80	-.37	.05

ELA, English/language arts; SES, socioeconomic status; BMI %tile, body mass index percentile. n = 261; Correlations of variables with canonical functions >.60 are shown in bold.

*
p < .01.